Claims

We claim:

1. An electronic structure, comprising:

a substrate;

an electronic device coupled to the substrate by an electrically conductive interconnect; and

an underfill disposed in a space between the electronic device and the substrate, wherein an upper portion of the underfill is adjacent to the electronic device, wherein a lower portion of the underfill is adjacent to the substrate, wherein the underfill encapsulates the electrically conductive interconnect, wherein the underfill comprises a resin and a filler, wherein the density of the filler is less than the density of the resin, and wherein the weight percent concentration of the filler in the underfill is higher in the upper portion of the underfill than in the lower portion of the underfill.

2. The electronic structure of claim 1, wherein the lower portion of the underfill is essentially free of the filler.

3. The electronic structure of claim 1, wherein the filler includes a hollow sphere particle.

4. The electronic structure of claim 1, wherein the filler includes borosilicate glass.

5. The electronic structure of claim 1, wherein the filler includes alumina or silica.

6. The electronic structure of claim 1, wherein the filler includes particles each having a dimension that does not exceed a distance between the electronic device and the substrate.

7. The electronic structure of claim 1, wherein a coefficient of thermal expansion (CTE) of the upper portion of the underfill is within about -8 ppm/°C to about +22 ppm/°C relative the CTE of a solder portion of the electrically conductive interconnect.

8. The electronic structure of claim 1, wherein a coefficient of thermal expansion (CTE) of the upper portion of the underfill is between about 20 ppm/°C and about 50 ppm/°C.

9. The electronic structure of claim 1, wherein an average weight percent of the filler within the underfill is between about 5% and about 30%.

10. The electronic structure of claim 1, wherein the electronic device includes a semiconductor chip.

11. The electronic structure of claim 10, wherein the substrate includes a chip carrier.

12. A method for forming an electronic structure, comprising:

providing a substrate with a conductive pad coupled to the substrate;

providing an electronic device with a solder member coupled to the electronic device;

soldering the solder member to the conductive pad to form an electrically conductive interconnect that couples the electronic device to the substrate, wherein the solder member is transformed into a solder portion of the electrically conductive interconnect;

dispensing an underfill in a space between the electronic device and the substrate, wherein an upper portion of the underfill is adjacent to the electronic device, wherein a lower portion of the underfill is adjacent to the substrate, wherein the underfill encapsulates the electrically conductive interconnect, wherein the underfill comprises a resin and a filler, and wherein the density of the filler is less than the density of the resin; and

curing the underfill after which a weight percent concentration of the filler in the underfill is higher in the upper portion of the underfill than in the lower portion of the underfill.

13. The method of claim 12, wherein after curing the underfill the lower portion of the underfill is essentially free of the filler.

14. The method of claim 12, wherein the filler includes a hollow sphere particle.

15. The method of claim 12, wherein the filler includes borosilicate glass.

16. The method of claim 12, wherein the filler includes alumina or silica.

17. The method of claim 12, wherein the filler includes particles each having a dimension that does not exceed a distance between the electronic device and the substrate.

18. The method of claim 12, wherein after curing the underfill a coefficient of thermal expansion (CTE) of the upper portion of the underfill is within about -8 ppm/°C to about +22 ppm/°C relative the CTE of the solder portion of the electrically conductive interconnect.

19. The method of claim 12, wherein after curing the underfill a CTE of the upper portion of the underfill is between about 20 ppm/°C and about 50 ppm/°C.

20. The method of claim 12, wherein a weight percent concentration of the filler within the underfill, as dispensed during dispensing the underfill, is between about 5% and about 30%.

21. The method of claim 12, wherein the electronic device includes a semiconductor chip.

22. The method of claim 21, wherein the substrate includes a chip carrier.

23. The method of claim 12, wherein curing the underfill includes heating the underfill.

24. The method of claim 23, wherein heating the underfill is for a temperature and time

appropriate for the resin to become 100% cross-linked or near-100% cross-linked.

25. A method for forming an electronic structure, comprising:

providing a substrate with conductive pads coupled to the substrate;

providing an electronic device with solder members coupled to the electronic device;

dispensing an underfill on the substrate and over the conductive pads, wherein the underfill comprises a resin and a filler, and wherein the density of the filler is less than the density of the resin;

moving the electronic device toward the substrate and into the underfill such that the solder members of the electronic device are aligned over corresponding conductive pads of the substrate, said moving occurring until the solder members are proximate the corresponding conductive pads; and

heating the electronic device resulting in soldering the solder members to the corresponding conductive pads to form electrically conductive interconnects that couple the electronic device to the substrate, wherein the solder members are each transformed into a solder portion of the electrically conductive interconnect, wherein after the heating a weight percent concentration of the filler in the underfill is higher in an upper portion of the underfill that is adjacent to the electronic device than in a lower portion of the underfill that is adjacent to the substrate.

26. The method of claim 25, wherein after heating the electronic device the lower portion of the underfill is essentially free of the filler.

27. The method of claim 25, wherein the filler includes a hollow sphere particle.

28. The method of claim 25, wherein the filler includes borosilicate glass.

29. The method of claim 25, wherein the filler includes alumina or silica.

30. The method of claim 25, wherein the filler includes particles each having a dimension that does not exceed a distance between the electronic device and the substrate.

31. The method of claim 25, wherein after heating the electronic device a coefficient of thermal expansion (CTE) of the upper portion of the underfill is within about -8 ppm/°C to about +22 ppm/°C relative the CTE of the solder portion of the electrically conductive interconnect.

32. The method of claim 25, wherein after heating the electronic device a CTE of the upper portion of the underfill is between about 20 ppm/°C and about 50 ppm/°C.

33. The method of claim 25, wherein a weight percent concentration of the filler within the underfill, as dispensed during dispensing the underfill, is between about 5% and about 30%.

34. The method of claim 25, wherein the electronic device includes a semiconductor chip.

35. The method of claim 34, wherein the substrate includes a chip carrier.

36. The method of claim 25, wherein heating the electronic device includes heating to a temperature of at least a melting temperature of a solder that is used for effectuating said soldering.

37. The method of claim 25, further comprising prior to dispensing the underfill, heating the substrate to a temperature that is sufficient for lowering a viscosity of the resin such that the particles of the filler are able to move through the resin.

38. The method of claim 37, wherein the sufficient temperature for so lowering a viscosity of the resin is between about 50 °C and about 110 °C.